CLAIMS:

1. A method of forming a semiconductor microstructure, the method comprising:

positioning a substrate in a process chamber;

flowing a process gas comprising a nitrogen-containing oxidizing gas in the process chamber; and

forming an oxynitride layer on the substrate, the oxynitride layer being formed in a self-limiting oxidation process, wherein the partial pressure of the nitrogen-containing oxidizing gas in the process chamber is less than about 10 Torr.

2. The method according to claim 1, wherein the thickness of the oxynitride layer is less than about 15 A.

3. The method according to claim 1, wherein the thickness of the oxynitride layer is less than about 10 A.

4. The method according to claim 1, wherein the thickness uniformity of the oxynitride layer varies less than about 1 A over the substrate.

5. The method according to claim 1, wherein the substrate diameter can be greater than about 195 mm.

6. The method according to claim 1, wherein the partial pressure of the nitrogen-containing oxidizing gas in the process chamber is less than about 5 Torr.

7. The method according to claim 1, wherein the nitrogen-containing oxidizing gas comprises at least one of NO, N_2O, and NH_3.

8. The method according to claim 1, wherein the process gas further comprises an oxygen-containing gas.

9. The method according to claim 8. wherein the oxygen-containing gas comprises at least one of O_2, O_3, H_2O, and H_2O_2..

10. The method according to claim 1, wherein the process gas further comprises an inert gas.

11. The method according to claim 10, wherein the inert gas comprises at least one of Ar, He, Ne, Kr, Xe, and N_2.

12. The method according to claim 1, wherein the substrate temperature is between about 500° C and about 1000° C.

13. The method according to claim 1, wherein the substrate temperature is about 700° C.

14. The method according to claim 1, wherein the substrate comprises Si and the oxynitride layer comprises SiO_xN_y.

15. The method according to claim 1, further comprising exposing the oxynitride layer to a plasma nitridation process.

16. The method according to claim 15, wherein the plasma nitridation process utilizes a process gas comprising at least one of N_2, NO, N_2O, and NH_3.

17. The method according to claim 1, further comprising post-annealing the oxynitride layer using a process gas comprising at least one of N_2O and O_2.

18. The method according to claim 1, wherein the positioning comprises positioning a substrate containing an initial dielectric layer in a process chamber.

19. The method according to claim 18, wherein the initial dielectric layer is formed in a self-limiting oxidation process.

20. The method according to claim 18, wherein the initial dielectric layer comprises at least one of an oxide layer, an oxynitride layer, and a nitride layer.

21. The method according to claim 20, wherein the oxide layer comprises SiO_2, the oxynitride layer comprises SiO_xN_y, and the nitride layer comprises SiN_x.

22. The method according to claim 1, wherein the processing chamber pressure is below atmospheric pressure.

23. The method according to claim 22, wherein the processing chamber pressure is less than about 50 Torr.

24. A microstructure comprising:

a substrate;

an oxynitride layer on the substrate, the oxynitride layer being formed in a self-limiting oxidation process in a process chamber, wherein the partial pressure of a nitrogen-containing oxidizing gas in the process chamber is less than about 10 Torr.

25. The microstructure according to claim 24, wherein the thickness of the oxynitride layer is less than about 15 A.

26. The microstructure according to claim 24, wherein the thickness of the oxynitride layer is less than about 10 A.

27. The microstructure according to claim 24, further comprising:

a high-k layer deposited on the oxynitride layer; and

an electrode layer on the high-k layer.

28. The microstructure according to claim 27, wherein the high-k layer comprises at least one of HfO_2, ZrO_2 , Ta_2O_5, TiO_2, Al_2O_3, and HfSiO.

29. The microstructure according to claim 27, wherein the electrode layer comprises at least one of W, Al, TaN, TaSiN, HfN, HfSiN, TiN, TiSiN, Re, Ru, and SiGe.

30. A processing system comprising:

a process chamber;

a gas injection system configured to introduce a process gas in the process chamber, wherein the process gas comprises a nitrogen-containing oxidizing gas;

a substrate holder, the substrate holder exposes a substrate to the process gas in the process chamber, wherein an oxynitride layer is formed on the substrate in a self-limiting process, wherein the partial pressure of a nitrogen-containing oxidizing gas in the process chamber is less than about 10 Torr; and

a controller that controls the processing system.

31. The processing system according to claim 30, wherein process chamber comprises a batch type process chamber.

32. The processing system according to claim 30, wherein process chamber comprises a single wafer process chamber.

33. The processing system according to claim 30, further comprising a process monitoring system and a pumping system.

34. The processing system according to claim 30, wherein the substrate comprises Si and the oxynitride layer comprises SiO_xN_y.

35. The processing system according to claim 30, wherein the partial pressure of the nitrogen-containing oxidizing gas in the process chamber is less than about 5 Torr.

36. The processing system according to claim 30, wherein the nitrogen-containing oxidizing gas comprises at least one of NO, N_2O, and NH_3.

37. The processing system according to claim 30, wherein the process gas further comprises an oxygen-containing gas.

38. The processing system according to claim 37, wherein the oxygen-containing gas comprises at least one of O_2, O_3, H_2O, and H_2O_2.

39. The processing system according to claim 30, wherein the process gas further comprises an inert gas.

40. The processing system according to claim 39, wherein the inert gas comprises at least one of Ar, He, Ne, Kr, Xe, and N_2.

41. The processing system according to claim 30, wherein the substrate temperature is between about 500° C and about 1000° C.

42. The processing system according to claim 30, wherein the substrate temperature is about 700° C.

43. The processing system according to claim 30, wherein the processing chamber pressure is below atmospheric pressure.

44. The processing system according to claim 43, wherein the processing chamber pressure is less than about 50 Torr.